Battery Health Monitoring System Based on PLC

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Abstract: ***Batteries are the heart of the UPS system, and its applications are more in all the fields, where the electrical supply requires. The periodical monitoring/observations are required for battery source to provide continuous power to the load without any interruption. Mainly, when the batteries are connected in the form of online/no-break UPS system, the critical monitoring is essential for providing quality power to increase the performance of the load. The existing/conventional system is configured to monitor the line voltage and load current of the battery bank; with this the individual cell/battery performance and their status cannot be monitored. This proposed PLC based battery health monitoring system eliminates the above discussed problems. This system monitors the individual battery's electrical parameters through SCADA. This system is incorporated with GSM module and room temperature measurements. GSM module is for giving alert message to authorized person whenever the condition of the battery is under critical and the room temperature increases than the set value.***

Keywords: Voltage, Load current, Cycles Life, Charge/Discharge, Time, PLC and SCADA.

1. Introduction

Monitoring the each battery in the battery bank ensures the battery system operating levels and conditions remains optimal. And the battery should provide a power without interrupting the device operations of the system in the absence of ac input power. In order to provide the power for the systems in the absence of ac input, the battery should be in good condition to provide the sufficient amount of power to the devices without interruption. In order to know the condition of battery, it does require monitoring the each battery in the battery bank periodically in real time. The main goal of this system is to inform the users regarding the present status or condition of individual battery in the battery bank periodically and sends the alert message to authorized person through GSM. To know the present status of battery some important parameters of the battery should be measure in regular interval. The important parameters are terminal voltage, load current, capacity, discharge current and room temperature of each battery.

This monitoring system measures the parameters like terminal voltage, load current, discharge current, capacity and room temperature of individual battery periodically in the battery bank. By using these measured parameters the present status of battery can be determined easily. And by measuring and performing some operations of these parameters in PLC controller the state of charge (SOC), life cycles, Discharge time and State of health (SOH) of individual battery in the battery bank can be known. The Programmable logic Controller is used in this project to measure the parameters of each battery and that will display on personal computer by using SCADA. The parameters will be measure for regular intervals and in real time and store it on the controller memory and transform to PC. Here in this developed project the method is going to test only 2 batteries. But by using the same PLC controller it can develop a method to monitor the number of batteries in the battery bank.

2. Battery Basics

Battery is a device which converts chemical energy into electrical energy [1]. There are a variety of batteries in use, each with its own advantages and disadvantages. There are two main categories of batteries are Primary Batteries, sometimes also called single-use, or "throw-away" batteries because they have to be discarded after they run empty as they cannot be recharged for reuse and Secondary Batteries, mostly called rechargeable batteries because they can be recharged for reuse. Primary batteries are Carbon Zinc, Alkaline, Lithium Cells, Silver Oxide Cells and Zinc Air Cells and Secondary Batteries are Rechargeable Alkaline, Nickel-Cadmium, Lithium Ion and Lead acid [1].

2.1 Battery Technical Specifications

This section explains the specifications you may see on battery technical specification sheets used to describe battery cells [2].

2.1.1Nominal Voltage (V)

The reported or reference voltage of the battery, also sometimes thought of as the "normal" voltage of the battery [1].

2.1.2Cut-off Voltage

It is the minimum allowable voltage. It is that voltage which generally defines the "empty" state of the battery.

2.1.3Capacity

The capacity, the total Amp-hours available when the battery is discharged at a certain discharge current (specified as a C-rate) from 100 percent state-of-charge to the cut-off voltage. Capacity is calculated by multiplying the discharge current (in Amps) by the discharge time (in hours) and decreases with increasing C-rate.

2.1.4Life Cycles

The number of discharge-charge cycles the battery can experience before it fails to meet specific performance criteria. Cycle life is estimated for specific charge and discharge conditions. The actual operating life of the battery is affected by the rate and depth of cycles and by other conditions such as temperature and humidity [2].

a. Internal Resistance

It is defined as the opposition to the flow of current within the battery, which is generally different for charging and discharging and also dependent on the battery state of charge. As internal resistance increases, the battery efficiency decreases and thermal stability is reduced as more of the charging energy is converted into heat. Generally it is different for charging and discharging.

b. Discharge Current

The maximum current at which battery gets discharge continuously. This limit is usually defined by the battery manufacturer in order to prevent excessive discharge rates that would damage the battery or reduce its capacity [2].

3. Methodology

The block diagram of battery health monitoring system is shown in figure 1, which consists of PLC controller which fetches the measured parameters such as terminal voltage, charge current, and load current, room and battery temperature from the each battery in the battery bank.

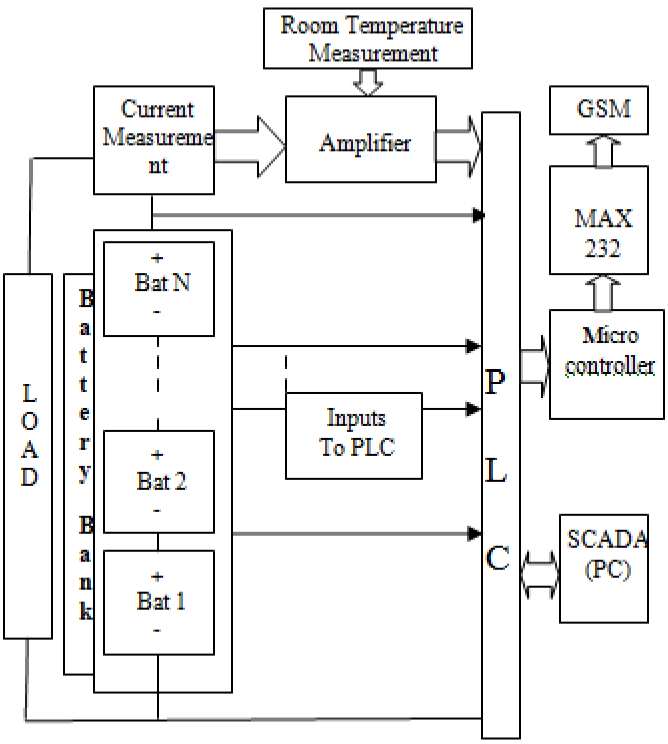

Figure 1: System Block Diagram

3.1 Description

The data measured by PLC is then used to calculate the other parameters like capacity, load current, state of charge (SOC), discharge time and State of health (SOH) of each battery, which determine the present status or condition of each battery. And SCADA is used here to display the measured parameters in the personal computer in real time. The system counts the number of discharge cycles and measure the discharge time of each battery, and by comparing these values with predetermined Life cycles by manufacturer and previous discharge time value, this system going to tell the operating life of each battery in battery bank and sends the alert message through GSM .

3.2 Sensors

3.2.1. Current Measurement

Current measurement sensor is used to measure the load and discharge current of each battery in battery bank. It works on the principle of Hall Effect and the characteristics say us that voltage sensitivity of output varies linearly with the current measured in the system. The current sensor used here is WCS2702.

3.2.2 Temperature Measurement

Temperature measurement sensor is to sense the temperature of battery in the room temperature of room in which battery bank is installed. The temperature sensor used for detecting room temperature is LM35.

3.3 PLC Controller

Programmable Logic controller is a specialized computer used to accept the data in any form and control the machine and process. It uses programmable memory to store instructions and specific functions that include on/off control, timing, counting, arithmetic and data handling. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a *hard* real time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result [6].

There are five basic components in a PLC system such as PLC processor, or controller, I/O (Input /Output) modules, Chassis or backplane, Power supply, Programming software that runs in a PC In addition to these 5, most PLCs also have network interface. The PLC used in this project is Micro Logix 1400[6].

3.4 SCADA system

Supervisory control and data acquisition is a computer system for gathering and analyzing real time data. SCADA systems are used to monitor and control a plant or equipment in industries such as telecommunications, here its used to display the parameters of individual battery [6].

3.5 Microcontroller

The purpose of microcontroller is to send the alert message through the GSM modem. On receiving the information from PLC the particular port pins of microcontroller will be made high and that particular alert information is transmitted as a message through the GSM modem. The microcontroller used here is AT89S52 controller [7].

3.6 GSM System

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. The purpose of GSM modem is to alert the authorized person about battery and temperature condition.

4. Experimental Results

The experimental results for good battery and battery may lead to fail are shown in figure 2 and figure 3. This tells present status of each battery and displays the battery parameters. By using these results the user can know the present condition of battery and if the battery which may lead to fail tells the user that he/she has to remove that battery n the bank and replace with good battery. That removed battery internal resistance has to check manually and by this way he/she can determine the battery operating Life.

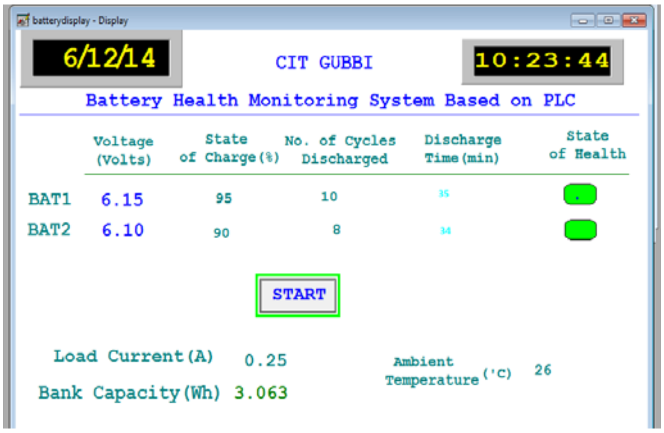

Figure 2: Snap Shots of Displaying Battery parameters on SCADA (Good Battery)

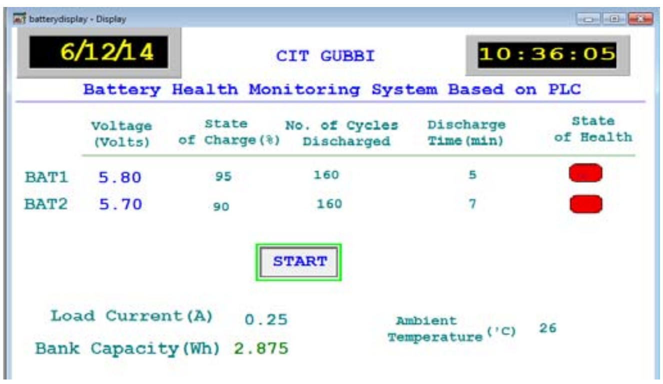

Figure 3: Snap Shots of Displaying Battery parameters on SCADA (Battery may Lead to Fail)

5. Conclusion

This system utilizes the advance PLC controller and SCADA system to monitor and display the parameters of the individual battery in the battery bank in real time and informs the users about the battery present status by displaying on SCADA and through GSM it sends the, alert message to authorized person about battery condition and room temperature. By monitoring each battery in battery bank one can improve the system reliability by detecting battery problems at early stage before they can cause an abrupt system failure to other power handled system in the absence of ac power. By using discharge time and number of discharge cycles, it's going to tell the status of individual battery in battery bank.

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